

A POPULATION SURVEY OF FOREST-DWELLING  
RHESUS MONKEYS (PRIMATES : CERCOPITHECIDAE)  
IN NORTH INDIA<sup>1</sup>

*By*

PHYLLIS DOLHINOW

*University of California, Berkeley*

and

D. G. LINDBURG

*University of California, Los Angeles*

*University of California, Berkeley, California 94720*

(With 3 Text-figures and 7 Tables)

INTRODUCTION

The status of rhesus monkey (*Macaca mulatta* Zimmerman 1780) populations is better known than that of most other primates as a result of surveys undertaken in north India at periodic intervals since 1959 (Southwick *et al.*, 1961*a, b*; Southwick and Siddiqi, 1966, 1968; Southwick *et al.*, 1964; Mukherjee and Mukherjee, 1972). These surveys sampled rhesus monkey populations in various habitats; however, figures for forest-dwelling groups were based on survey of an area of only approximately 26 km<sup>2</sup>. We present here the results of more extensive surveys conducted during 1964 and 1965 in forested areas of the north Indian states of Uttar Pradesh, Punjab, and Himachal Pradesh. Although it is expected that the numbers of monkeys in the sampled areas have changed in the years since our study was made, our results represent an important baseline for comparison with other surveys—especially the nation wide survey India is now undertaking.

The forests of present-day India represent a small but significant percentage of the total rhesus monkey habitat, and for many years the monkeys in these areas were relatively inaccessible to trapping for biomedical use. Forest groups have been a major source of rhesus monkeys for only the last 5 to 7 years (Southwick, personal communication).

Because there have been extensive surveys of rhesus monkeys living in rural and urban areas, the major goal of our work was to assess the abundance of those in forest areas. Of the more than 9,400 km surveyed, 1582 were along forest roads in portions of the Himalayan foothills.

---

1. This research was supported by National Institutes of Health Grant FR-00169 to the California Primate Research Center, Davis, California 95696, U. S. A.

We include data on surveys conducted in non-forest regions—areas designated below as *rural* and *urban*—to draw comparisons between our findings and those reported by Southwick and his colleagues for independent surveys they carried out in Uttar Pradesh during approximately the same period of time.

#### METHODS

Our survey took place between October, 1964 and June, 1965. Methods for locating groups in forest and rural habitats were basically the same as those used by Southwick *et al.*, (1961*b*) in their survey of transportation routes, *i. e.*, travel over passable roadways in a vehicle from which the authors scanned adjacent areas. Travel was at slow speeds, rarely exceeding 30 km per hour. We regularly surveyed throughout the day, including portions of the interval from 1100 to 1500 hours, regarded by Southwick and colleagues as potentially less productive in locating groups. In urban areas, we confined our attention to those groups encountered in traveling through the towns and cities along our roadside survey routes. In determining incidence of groups per km of travel, we have excluded urban groups and urban travel from the data.

As each group was sighted it was counted, and, only then, efforts were made to entice it with peanuts into open areas where counting was easier. (The one exception was in towns and cities where feeding tended to attract large numbers of curious humans.) Where observation conditions permitted, composition data were obtained using the age and sex categories defined by Southwick *et al.*, (1961*a*). In addition we noted general activity of groups at time of sighting, evidence of mating, impressions of health, and such habitat features as elevation, topography, type of vegetation, water source, human habitations, and associated fauna.

Our classification of rhesus monkey habitats into *forest*, *rural*, and *urban* differs substantially from the categories used by Southwick *et al.*, (1961*a*, 1961*b*). The authors have commented on the arbitrary nature of certain habitat designations. For example, groups found near villages which are located along roadsides could be placed in either a *roadside* or *village* category. They resolved this problem “by determining which locale represented the usual and most frequent habitation of the groups” (1961*b*, p. 701). We found that such determinations were often difficult to make on the basis of the limited amount of time it was possible to spend with each group. Furthermore, it is our contention that the most important habitat distinctions are those reflecting the amount of each

group's contact with the human populace. From this standpoint, forest areas constitute a fairly homogeneous portion of the total range of habitats. Non-forest groups were divided into *urban* and *rural*, the distinguishing factor being presumed access of groups designated as *urban* to prominent bazaar areas. Usually, groups frequenting bazaars, whether located in cities, villages, or temples, move freely through dense concentrations of humans and are least dependent on natural foods and foraging for subsistence. Our rural category includes groups intermediate between *forest* and *urban* in amount of human contact. While frequenting roadside trees and adjacent fields certain of these groups regularly visited small mud villages, or tea shops at rural crossroads.

For purposes of data analysis, we assigned group counts to one of three categories: "complete", "incomplete", or "no count attempted." Groups which fled at contact or which were seen on the rooftops of a distant village are examples of circumstances under which it was impossible to obtain a count. For the remainder, ease of observation was the primary criterion for judging completeness of counts. For example, groups seen in nearby open fields or groups which responded to feeding were obviously much easier to count than those which remained partially concealed in tall grass or roadside trees. In a few instances group composition was used as an additional indication of completeness of counts, as, for example, a tally showing substantially more infants than adult females was considered incomplete.

Most of our survey in forest areas coincided with the beginning the 1965 birth season and, as a result, we sighted nearly one hundred newborn infants. Because other habitat types were not surveyed at this time of year, newborn infants have been excluded from the totals.

## RESULTS

Groups in rural habitats were much more easily counted than those in forests or urban areas. Counts of 48.4% of the groups sighted in

TABLE 1. Rhesus monkey groups encountered in various habitats under both survey and non-survey conditions.

Habitat	Number of Groups			Total	Per cent
	Complete counts	Partial counts	No count attempted		
Forest	32	48	61	141	28.1
Rural	119	78	49	246	49.1
Urban	18	23	73	114	22.8
Total	169	149	183	501	100.0

rural habitats were judged complete, compared to 22.6% for forest, and 15.8% for urban habitats (table 1). These figures reflect in a general way differences in shyness of groups and differences in habitat features which obstructed our view. That rural groups were least shy is further supported by the fact that 54% of feeding attempts in this habitat were successful, compared to only 11% for forest groups. Despite their greater shyness, on several occasions forest groups could be counted as we came upon them resting in the open or drinking at a stream.

Validity of the distinction between complete and partial group counts was assessed by computing separate means for group size in each habitat category. The discrepancy is greatest for forest and urban habitats, where partially counted groups are smaller by an average of 10.4 and 8.8 individuals per group respectively. The distinction seems least valid for rural habitats, where the difference was only 0.6 individuals per group.

*Incidence of groups*: The total number of groups sighted in all habitats and under both survey and non-survey conditions is given in table 1. Incidence of groups is determined, however, by using only those sighted under survey conditions (242 groups in rural habitats, and 134 in forests). Our systematic survey covered a total of 9,510 original km (km which were not resurveyed) 16.6% of which were in forest areas (table 2). Groups were thus located at a rate of one for each 11.6 km

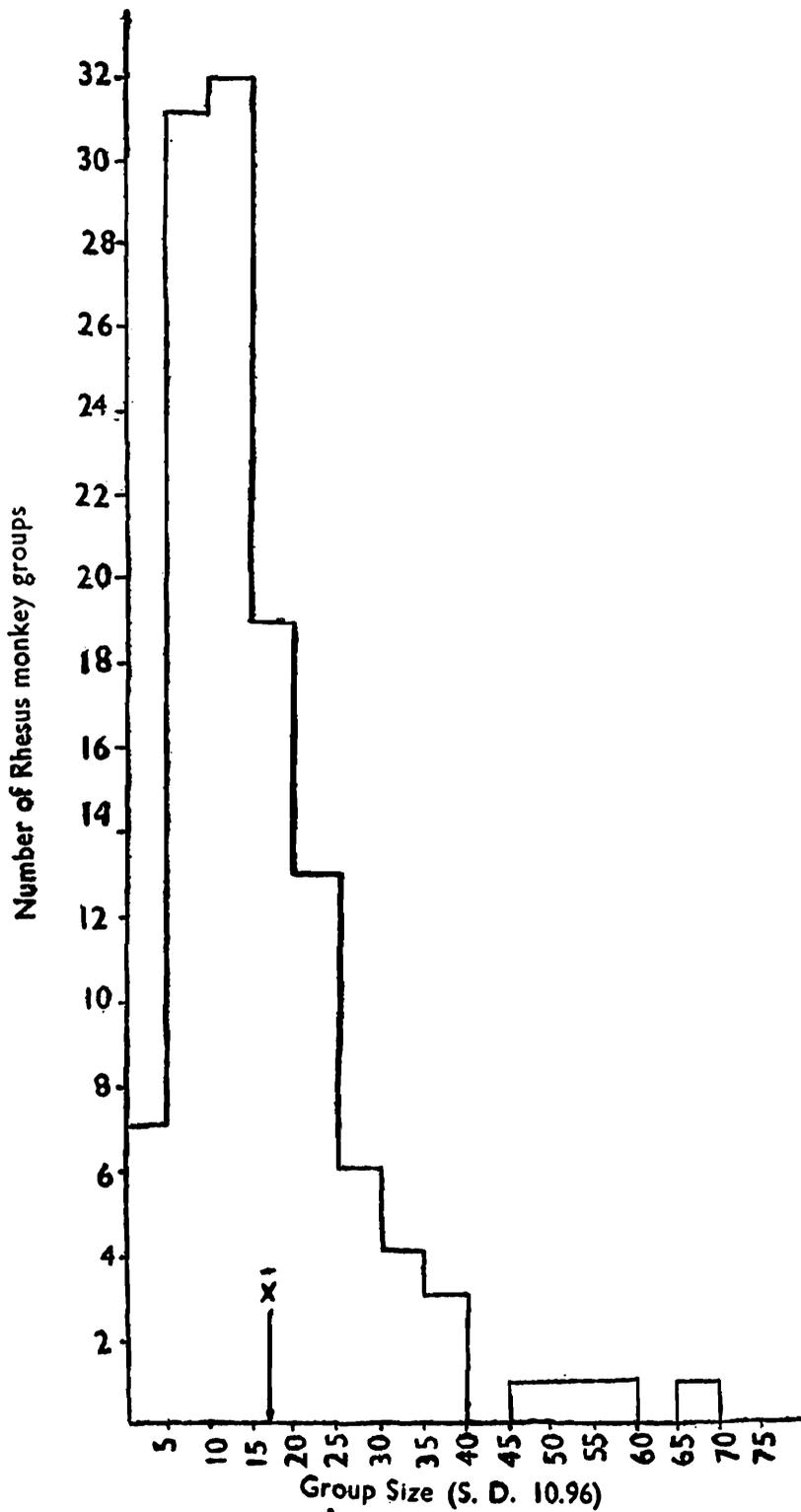
TABLE 2. Incidence of groups of rhesus monkeys in forest and rural surveys in Uttar Pradesh, Punjab, and Himachal Pradesh.

State	Forest Roads			Rural Roads		
	km travelled	Groups* seen	km per group	km travelled	Groups* seen	km per group
Uttar Pradesh	1,454	125	11.6	5,509	218	25.3
Punjab	16	0	—	1,882	21	89.6
Himachal Pradesh	113	9	12.5	539	3	179.7
	<u>1,583</u>	<u>134</u>	<u>11.8</u>	<u>7,930</u>	<u>242</u>	<u>32.8</u>

\* Does not equal totals in Table 1, since a few groups were sighted on non-survey occasions.

of forest road, compared with one for each 32.8 km of rural travel ( $P_1$  0.025,  $x^2$ ). A breakdown of survey routes by state reveals that there were fewer rhesus groups in rural habitats in Punjab and Himachal Pradesh than in Uttar Pradesh (table 2). The incidence in forest areas for these two states approaches that for Uttar Pradesh, but is based on only 129 km of forest travel.

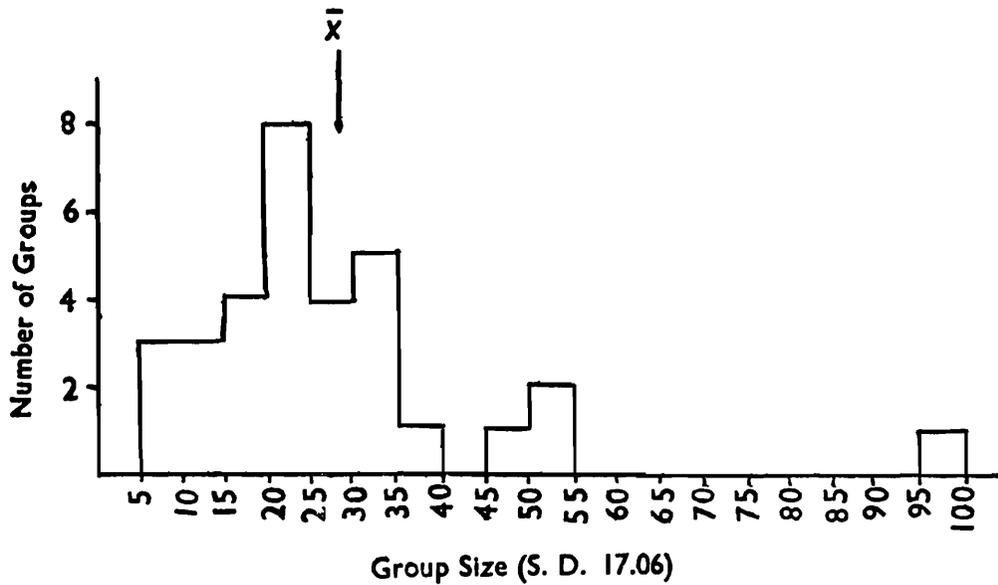
Although sampling urban groups was incidental to forest and rural surveys, it is interesting that only 16 urban groups were seen in all of Punjab, three in the hill city of Simla, and the remainder within a radius



Text-fig. 1. Group size of rhesus monkey groups living in rural habitats in India.

of 100 km from New Delhi. Apart from the groups in this region of Punjab, and an occasional group in the Himalayan foothills, it would appear that there are few if any rhesus monkeys in most areas of the state of Punjab.

*Group size* : In pair-wise comparisons differences in mean size of groups for our three habitats (table 3) were insignificant (Chi square test).

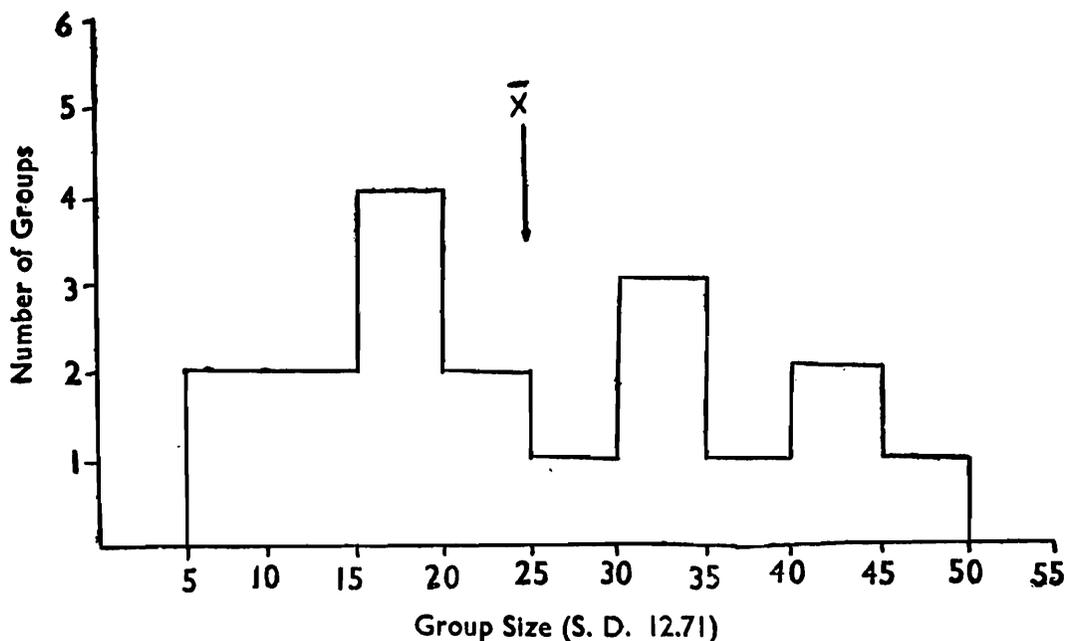


Text-fig. 2. Number of groups and group size in forest habitats.

TABLE 3. Average group size and composition for rhesus monkeys in forest, rural and urban habitats.

Habitat	N	Mean Size	Adults		Immatures	
			Males	Females	Juveniles	Infants
Forest	32	28.2±3.01	3.6±0.39	10.7±1.26	7.7±0.1	6.2±0.62
Rural	119	16.4±1.0	3.4±0.18	6.5±0.4	1.6±0.34	4.8±0.29
Urban	18	25.6±2.99	3.9±0.48	9.7±1.12	4.2±0.87	7.7±0.91

While forest-dwelling groups were larger, on the average, than groups in other habitats, they were smaller by nearly 50% than has been repor-



Text-fig. 3. Number of groups and group sizes in urban habitats.

ted previously (Southwick, Beg and Siddiqi. 1961*b*). The ranges in group sizes for rural, forest, and urban habitats are shown in figures 1, 2, and 3.

*Group composition* : The number of adult males per group was fairly similar in all three habitat types despite differences in mean group size (table 3). All remaining age and sex categories averaged fewer individuals in rural than in forest or urban groups, however. The greatest difference was in number of juveniles, with forest groups averaging 7.7, while rural groups had only 1.6 juveniles per group. Urban groups had intermediate values for females and juveniles, but had the highest incidence of infants. It is possible that the relatively low number of infants in forest groups was due in part to errors in classification of immatures as discussed below.

*Habitat usage* : In forest areas we found a higher percentage of groups in relatively pure *Shorea robusta* (*sal*) forests than in any other type of vegetation (table 4). These findings reflect to some extent the

TABLE Per cent of group sightings in different types of forest vegetation.

<i>Type of forest</i>	<i>Per cent</i>
Predominantly <i>Shorea robusta</i>	31.2
Less pure <i>Shorea robusta</i> , plus mixed deciduous	23.4
Mixed deciduous, with very little <i>Shorea robusta</i>	23.4
Predominantly <i>Dalbergia sissoo</i>	15.6
Other ( <i>e. g.</i> pine, deodar)	6.4
	100.0

prevalence of different types of vegetation in northern India. In the Dehra Dun Forest Division of Uttar Pradesh, for example, 79% of the forest is classified as *sal* (Nath, 1963). In a study of forest groups near Dehra Dun, Lindburg (1971, 1976) found that *sal* was utilized as food by rhesus monkeys more than any other single species, but that food preferences varied greatly on a seasonal basis. Additional confirmation of this point is found in our observations of groups concentrated in *sheesham* (*Dalbergia sissoo*) forest in Corbett Park during in the winter season, whereas Southwick's survey of the same area in the dry season indicated a preference for mixed deciduous forest (Southwick 1961*b*). The type of vegetation in which a group is seen in a brief encounter may not be preferred by that group on a year round basis.

For rural groups located along roadsides, although several species were often present at each sighting, the mango tree (*Mangifera indica*) occurred in 69% of the locations for which we collected this kind of

information (N=204). The prevalence of other tree species at group locations (table 5) probably reflects incidence of tree types along roadsides more than preferences by the monkeys.

TABLE 5. Prevalence of different species of trees in roadside habitats of rhesus monkeys.

Species	Vernacular	Per cent of sightings
<i>Mangifera indica</i> Linn.	mango	69.1
<i>Azadirachta indica</i> A. Juss.	neem	29.9
<i>Dalbergia sissoo</i> Roxb.	sheesham	26.9
<i>Ficus religiosa</i> Linn.	pipal	19.6
<i>Ficus bengalensis</i> Linn.	banyan	14.2
<i>Syzygium cumini</i> (L.) Skeels.	jamun	11.3

#### DISCUSSION

In comparing results of our surveys with those of Southwick and his colleagues, we have used data from their 1964-1965 survey of rural and urban habitats (Southwick and Siddiqi, 1966, 1968). The only data for forest groups available for comparison are from their 1961 report. Comparisons are based on their *forest*, *roadside*, and *town* habitats, which we believe are the nearest equivalents to our three habitat categories. As a matter of convenience we shall hereafter refer to these earlier reports as the Southwick surveys.

*Incidence of groups* : Our results indicate an incidence of one group for each 32.8 km (20.3 mi) of rural survey, compared to one each 25.1 km (15.6) in Southwick's report. However, it should be noted that our effort included nearly 2,500 km of travel in Punjab and Himachal Pradesh, for which the incidence of groups per km was very low (table 2). When we limit the comparison to Uttar Pradesh, the incidence from our survey is one group each 25.3 km (15.7 mi) of travel, indicating remarkable close agreement with Southwick's findings.

Our survey of forest roads yielded an incidence of one group each 11.6 km of travel, which is more than twice as frequent as in rural areas of Uttar Pradesh. Southwick and Siddiqi (1966) have questioned the reliability of roadside survey in detecting forest groups, noting that they are not attracted to roadsides for food or sleeping trees as are groups living in rural areas. While we are in essential agreement with this observation, we believe forest roads may be attractive as open areas for sunning and grooming at certain times of day. Sightings in other instances were undoubtedly fortuitous. In any case, the results suggest

that an incidence of 0.7 groups per square mile of forest, as reported by Southwick, *et al.* (1961b), may be a conservative figure.

*Group size and composition* : The number of groups in each habitat category for which comparisons are made are indicated in table 6. For all age/sex categories in groups from *rural* areas, Southwick's figures are slightly lower than ours, resulting in a difference in mean size of 3.7 individuals per group. There is very close agreement on the incidence of juveniles per group. The overall difference in results for the two surveys could easily be a consequence of somewhat different classification of habitats. Our larger mean size is most likely a result of including in our data certain village groups which Southwick treated separately, and for which he reported a mean size of 24.4.

For *urban* habitats, although our sample is smaller, there is good agreement in results of the two surveys. The greatest difference is in approximately three more juveniles per group in Southwick's survey. Both surveys indicate a higher incidence of juveniles than was found in rural areas, but lower than that for forest groups.

The greatest discrepancy in results is for *forest* groups. We found the mean size of forest groups to be larger than in either rural or urban habitats, but only 28.2 individuals per group, compared to a mean of 49.8 reported by Southwick. This is the only habitat for which the difference in results from the two studies is statistically significant ( $p < 0.025$ , Chi square). Average numbers of individuals in all age/sex categories were higher in Southwick's survey, with the greatest difference being in numbers of adult females. These differences are not surprising, given the difference in sample size. (See table 6.)

*Population composition* : Although we found forest groups to be significantly smaller than Southwick has reported, there is remarkably close agreement between surveys in percent of individuals in the different age/sex categories (table 7). The composition of the rural population shows good agreement as well. In both surveys, percentages of adult males and infants in the three habitats were lowest for forest groups, whereas the forest population had the highest percentage of juveniles. We found the percentage of adult females to be nearly identical in all three habitats.

With respect to juveniles, the differences are undoubtedly a consequence of the amount of trapping for export which occurred in each habitat. The reasons for the low number of infants relative to number of sexually mature females in forests are not obvious. Given the generally better health and less frequent human contact for forest monkeys, we would expect conditions in this habitat to be the most

TABLE 6. Average group compositions compared with compositions for equivalent habitats in Southwick's survey. Column A=this survey ; column B=Southwick survey.

Habitat	N		MEAN GROUP SIZE		ADULT MALES		ADULT FEMALES		JUVENILES		INFANTS	
	A	B	A	B	A	B	A	B	A	B	A	B
Forest	32	5	28.2	49.8	3.6±0.39	5.6±0.7	10.7±1.26	19.2±1.7	7.7±0.1	13.6±2.9	6.2±0.62	11.4±0.7
Rural	119	118	16.4	12.7	3.4±0.18	2.5±0.13	6.5±0.4	5.2±0.29	1.7±0.34	1.5±0.32	4.8±0.29	3.5±0.24
Urban	18	41	25.5	27.3	3.9±0.48	4.0±0.3	9.7±1.12	9.1±0.7	4.2±0.87	7.1±0.8	7.7±0.91	7.1±0.6

TABLE 7. Population composition compared with composition in equivalent habitats from Southwick's survey. Column A=this survey ; column B=Southwick survey.

Habitat	Adult males		Adult females		Juveniles		Infants		Ad. male/Adults		Immatures/total		Infants Ad. females	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Forest	12.7	11.2	38.1	38.6	27.3	27.3	21.9	22.9	24.9	22.6	49.3	50.2	57.7	59.4
Rural	21.0	19.6	39.8	41.0	10.0	11.5	29.2	27.9	34.5	32.3	39.2	39.4	73.4	68.0
Urban	15.4	14.5	38.1	33.3	16.5	26.2	30.0	26.0	28.9	30.2	45.7	52.1	78.9	78.0

favourable for reproduction. It seems likely, therefore, that the low incidence of infants is a result of errors in classification. Forest surveys in both studies were conducted primarily in the dry season when infants of the previous birth season were approaching yearling size, possibly resulting in a number of them being erroneously counted as juveniles. It is also possible that, with a larger juvenile population in forests, classification of a number of larger juveniles as sexually mature females was a second source of error.

*Abundance of forest population* : In their 1960 survey of forest habitats in Uttar Pradesh, Southwick *et al.* (1961b) estimated an incidence of 0.7 groups in each square mile of forest. This figure was based on their success in detecting groups during foot travel through blocks of forest one square mile in size. By pausing frequently to listen for vocalizations or sounds of movement, they estimated that in the dry season animals the size of rhesus monkeys "could be heard for a distance of approximately 200 yards" (p. 700). For vehicular survey over forest roads we estimated a maximum detection range of 50 metres on either side. On this basis, conversion of linear distance to area equivalents (Southwick and Cadigan, 1972) yields an incidence of 0.91 groups/km<sup>2</sup>. Following the formula of Southwick *et al.* (1961b), and using the revised mean for group size from our surveys, we obtain an estimate of 200,000 rhesus monkeys in the forests of Uttar Pradesh for 1964-65. This figure compares with 100,000 estimated by Southwick *et al.* (1961b) for 1959-60. It is unlikely that forest population were experiencing a rate of growth which would account for an increase of this magnitude in only five years, particularly in view of the documented decline of the population in other habitats (Southwick and Siddiqi, 1966, 1968). It is more likely that abundance in 1959-60 was underestimated.

If incidence and size of groups in Himachal Pradesh, with 12,517 km<sup>2</sup> of forest (Government of India 1968), are the same as in Uttar Pradesh, as our limited sample indicates, then the total forest population for that state would fall between 60,000 and 70,000 monkeys. This figure is probably too high, however, since 66% of the forest in Himachal Pradesh is coniferous, compared to 27% for Uttar Pradesh (Government of India, 1968), and a very few groups in our total forest sample were found in coniferous forests (Table 4).

We have no census data for the approximately 18,000 km<sup>2</sup> of forest in Punjab, but were repeatedly informed by people in the country-side that rhesus monkeys survived in this state only in the foothill forests. Given their geographical proximity to broadly similar forests in Himachal Pradesh and the foothills of Uttar Pradesh, and a percentage of

non-coniferous vegetation identical to that of the latter state, it is possible that another 60,000 rhesus monkeys resided in the forests of Punjab.

#### ACKNOWLEDGEMENTS

We would like to thank Professor Charles H. Southwick for his very helpful comments on this manuscript.

#### SUMMARY

A survey of forest-dwelling groups of rhesus monkeys was undertaken during 1964 and 1965 in the north Indian states of Uttar Pradesh, Punjab, and Himachal Pradesh. A total of 9,510 km were surveyed, 16.6% of which were in forest areas. Forest survey revealed an incidence of one group each 11.6 linear kilometer of travel, and a mean size of 28.2 individuals. Comparisons are made here between groups of rhesus living in three habitats : forest, rural, and urban—categories reflecting amounts of contact with humans. Urban groups had access to prominent bazaar areas.

We observed a higher frequency of groups living in forests but a significantly lower mean group size than reported by earlier surveys. Our results from non-forest areas were in close agreement with the results of others surveys made at the same time. Fewer rhesus groups lived in rural habitats in Punjab and Himachal Pradesh than in Uttar Pradesh. The incidence in forest areas for these two states approaches that for Uttar Pradesh. It appears there were far fewer rhesus monkeys in Punjab state than in any other state surveyed.

#### REFERENCES

- Government of India (1968). Statistical abstract of the Indian Union 1967. New Series 15.—*Government of India Press*, New Delhi.
- LINDBURG, D. G. 1971. The rhesus monkey in north India : an ecological and behavioral study.—In : *Primate Behavior : Developments in Field and Laboratory Research*. 2. Rosenblum, Ed., pp. 1-106, New York (Academic Press).
- LINDBURG, D. G. 1976. Dietary habits of rhesus monkeys (*Macaca mulatta* Zimmerman) living in Indian forests. *J. Bombay nat. Hist. Soc.*, **73** : 261-269.
- MUKHERJEE, R. P. AND MUKHERJEE, G. D. 1972. Group composition and population density of rhesus monkeys (*Macaca mulatta* Zimmerman) in northern India.—*Primates*, **13** : 65-70,

- NATH, K. 1963. Working plan for the Dehra Dun Forest Division, Uttar Pradesh 1959-60 to 1968-69. Deputy Conservator of Forests, Naini Tal, Uttar Pradesh, India.
- SOUTHWICK, C. H., BEG, M. A. AND SIDDIQI M. R. 1961*a*. A population survey of rhesus monkeys in villages, towns and temples of northern India.—*Ecology*, **42** : 538-547.
- SOUTHWICK, C. H., BEG, M. A. AND SIDDIQI, M. R. 1961*b*. A population survey of rhesus monkeys in northern India : II. Transportation routes and forest areas.—*Ecology*, **42** : 698-710.
- SOUTHWICK, C. H. AND CADIGAN, F. C. JR. 1972. Population studies of Malaysian primates. *Primates*, **13** : 1-18.
- SOUTHWICK, C. H., GHOSH, A. AND LOUCH, C. D. 1964. A roadside survey of rhesus monkeys in Bengal. *J. Mammal*, **45** : 443-448.
- SOUTHWICK, C. H. AND SIDDIQI, M. R. 1966. Population changes of rhesus monkeys (*Macaca mulatta*) in India, 1959 to 1965. *Primates*, **7** : 303-314.
- SOUTHWICK, C. H. AND SIDDIQI, M. R. 1968. Population trends of rhesus monkeys in villages and towns of northern India, 1959-65. *J. Anim. Ecol.*, **37** : 199-204.